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PATENT SPECIFICATION 949,850

DRAWINGS ATTACHED.

949,850

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COMPLETE SPECIFICATION.

A Toothed Member and a Method of its Manufacture.

We, GENERAL ELECTRIC COMPANY, a Corporation organized and existing under the laws of the State of New York, United States of America, residing at 1 River Road, Schenectady 5, New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an improved torque-transmitting toothed member, such as a gear or a distance-piece coupling, and to a method of manufacturing such a toothed member.

High capacity gears such as a "bull gear" used in marine propulsion reduction gearing, can reach substantial sizes, ranging upwards as large as 200 inches in diameter. The gear tire is conveniently forged in a hollow cylinder which may have a wall thickness of as much as seven inches. The excess metal is machined from the blank and the teeth are cut therein, leaving a final wall thickness of less than half of the initial thickness. The cost of machining off the excess material, plus the fact that more than half the metal is unused, makes the fabrication of gears in this size range very expensive.

Therefore, the invention consists in a method of manufacturing a toothed member comprising the steps of providing a base member of readily weldable metal having good ductility, fusing to this base member an homogenous overlay of metal having higher strength and resistance to wear than the metal of which the base consists by performing multiple welding passes of a consumable metal electrode, each welding pass being fused with full penetration to the adjacent preceding pass and with minimum penetration into the base member, forming teeth in the weld overlay metal of a height less than the thickness of the overlay, and heat-treating the said member and overlay to produce teeth of high strength and wear resistant properties disposed on a base member of relatively lower strength properties but having good ductility and weldability.

The invention also consists in a toothed member manufactured by the method hereinbefore stated.

It will be appreciated that the manufacture of toothed members according to the invention is more economical because comparatively cheap material can be used for the base member and less excess material is required.

In order that the invention may be clearly understood, it will now be described in more detail by way of example with reference to the accompanying drawing, wherein:—

Figure 1 is a horizontal view, in section of a gear tire manufactured in accordance with the invention;

Figure 2 is an enlarged detail view in section, taken along lines 2—2 of Figure 1;

Figure 3 shows a flexible coupling sleeve with internal teeth manufactured in accordance with the invention; and

Figure 4 is a horizontal view, in section, of a coupling distance piece with spline teeth at opposite ends as manufactured in accordance with the invention.

Referring to Figure 1 of the drawing, a gear rim shown generally at 1 comprises a supporting or base portion 2 having two overlay portions 3, 4 deposited thereon. Suitable gear teeth, which may be of any type, but shown here as opposed helical teeth 5, 6 are machined thereon to form a herringbone gear. The teeth 5, 6 have a height which is less than the thickness of the overlay portion, so that the tooth lies entirely in the overlay.

The base 2, in this case, is fabricated from

low cost steel plate by rolling into a cylinder and butt welding or otherwise suitably joining the ends together. The base 2 may be selected from several suitable materials of low physical property metals which are readily weldable and which are generally regarded as not substantially hardenable by heat treating. A suitable material would be a low carbon steel such as SAE Type 1010 or 1020, which is available at only a fraction of what the cost of this portion of the rim would be if it were forged from high strength alloy. Since base 2 remains ductile even after the entire rim 1 has been heat treated, it may be easily welded to another supporting member such as a gear web (not shown).

Reference to Figure 2 will show more clearly how the overlay portion 4 is disposed on the base 2, the two metals fusing together along a fusion zone 7. It is particularly to be noted that fusion zone 7 is of a very small radial thickness, indicating only slight penetration of the overlay 4 into the base 2.

The overlay 4, which is applied with a welding process similar to continuous casting, by a method later to be described, is a high physical property material having alloying ingredients which impart substantial strength for withstanding the torque carried by gear teeth 6. The chemical composition of overlay 4 is affected by the flux but as shown here consists roughly of a composition similar to SAE Type 1040 medium carbon steel after application.

It is understood that the materials described are only one example of suitable compositions and are given as an example in order to illustrate the invention.

Figure 3 illustrates a flexible coupling sleeve shown generally at 8 comprising an external supporting member 9 with the overlay 10 deposited on the internal bore of support 9. Internal gear teeth 11 are machined in overlay 10 in a manner similar to the gear of Figure 1.

Figure 4 illustrates a coupling distance piece shown generally at 12. The supporting structure 13 is a piece of steel tubing of substantial length with overlay portions 14, 15 applied at opposite ends thereof and with spline teeth 16, 17 cut in the overlay portions 14, 15 respectively. Thus the support piece 13 may be manufactured from low cost tubing with the high physical property teeth 16, 17 only comprising a small portion thereof.

One method of applying overlay 4 to base member 2 of the gear illustrated in Figures 1 and 2 is outlined as follows. A submerged arc process utilizing dual filler wires of high physical property metal provides a suitable method for adding the high physical property material. The overlay is applied continuously as the gear is rotated, thus resulting in a helical application, with each pass being substantially applied to the previous pass so as to achieve minimum penetration into the base member 2. As a result, loss of alloying elements into the base 2 is substantially reduced. A suitable homogeneous overlay may be obtained by using a D.C. straight polarity weld at about 700 amperes and at a voltage of 25 to 28 volts with 30 to 40 cm. per minute travel speed. With the metals suggested above, preheating to about 150° C. improves the quality at the fusion zone and in the deposited material.

In order to achieve an overlay composition roughly corresponding to SAE Type 1040 carbon steel, the filler wires correspond to SAE Type 1060 steel. A flux such as Grade 80, 20XD, manufactured by Linde Air Products Company is suitable. As is familiar to those skilled in the art, the flux in the submerged arc application furnishes oxygen which, in its very active form, combines with part of the carbon in the SAE Type 1060 filler wire to form gaseous products. This the filler wire loses about 20 "points" of carbon and the resultant overlay composition thus corresponds roughly to SAE Type 1040 steel.

It is essential that each pass be applied substantially to the preceding solidified weld deposit metal, in order to prevent substantial penetration into the base structure. This is necessary in order to prevent diffusion of the carbon or any alloying materials which might be used into the base structure with a resultant loss of properties of the overlay portion.

After the overlay has been applied, the gear teeth or spline teeth are machined by conventional methods. The teeth, of course, lie entirely within the overlay portion so as to benefit from its extra strength. The entire piece may then be heat treated to give greater strength and wear resistance to the teeth while leaving the base portion substantially unaffected.

The foregoing procedure results in a very homogeneous overlay having similar physical characteristics throughout and quite suitable for machining teeth therein. The continuous weld build-up gives a very fine grain structure as opposed to that which would result if the teeth and rim were cast in one piece by conventional techniques. Similarly, the physical properties of the resulting overlay as produced by the foregoing procedure may be compared to the minimum physical properties of a typical forged rim by reference to the table below.

Properties	By Forging	By Weld Overlay Process
Hardness	190 BHN	220 BHN
Tensile strength	80,000 p.s.i.	106,000 p.s.i.
Yield strength	40,000 p.s.i.	63,000 p.s.i.
Per cent elongation	22%	23%
Endurance limit	49,000 p.s.i.	52,000 p.s.i.

It will be understood that the foregoing welding procedure and the materials used are only illustrative of those which might be suitably employed. The welding technique might also utilize inert gas shielding as a substitute for the submerged arc process. Moreover, a reciprocating application of the overlay with the welding head moving back and forth axially may be suitable in some cases, as compared with the above-described helically applied weld on a rotating gear.

While the term "gear" has been used herein, it is understood that any analogous torque-transmitting member may be manufactured by the foregoing procedure. The invention is especially useful where the member is of substantial size so as to allow savings by using a low cost supporting structure.

The foregoing procedure provides a very economical way to produce a torque-transmitting member with teeth of high physical property material which are of substantial uniform strength. The homogeneity of the overlay is the key to achieving this and when coupled with the ability to obtain such an overlay on a low cost supporting structure, an extremely useful product results. Its properties are further enhanced by the fact that the tooth portion may be hardened by heat treating to give greater strength and resistance to wear, while leaving the base member relatively ductile in order that further machining may be accomplished or so that the base member may be easily welded to further supporting structure, even after the teeth have been heat treated.

It will be understood that still other modifications may be made, and it is intended to cover in the appended claims all such modifications as fall within the scope of this invention.

WHAT WE CLAIM IS:—

1. A method of manufacturing a toothed member comprising the steps of providing a base member of readily weldable metal having good ductility, fusing to this base member an homogenous overlay of metal having higher strength and resistance to wear than the metal of which the base consists by performing multiple welding passes of a consumable metal electrode, each welding pass being fused with full penetration to the adjacent preceding pass and with minimum penetration into the base member, forming teeth in the weld overlay metal of a height less than the thickness of the overlay, and heat-treating the said member and overlay to produce teeth of high strength and wear resistant properties disposed on a base member of relatively lower strength properties but having a good ductility and weldability.

2. A toothed member comprising a base portion of readily weldable metal having good ductility, an overlay portion fused to the surface of the base portion and comprising multiple welding passes of heat treatable steel having higher strength and resistance to wear than the metal of which the base portion consists, each pass of the overlay portion having been fused with full penetration into the adjacent pass but with only slight penetration into the base portion, the overlay material being of such nature that it retains its heat treatable characteristics without substantial diffusion of the alloying elements into the base portion, and torque-transmitting teeth formed in the overlay portion of a radial height less than the radial thickness of the overlay portion.

3. A toothed member substantially as described with reference to and as illustrated in Figures 1 and 2, or Figure 3 or Figure 4 of the accompanying drawings.

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1 SHEET This drawing is a reproduction of the Original on a reduced scale

FIG. 1.

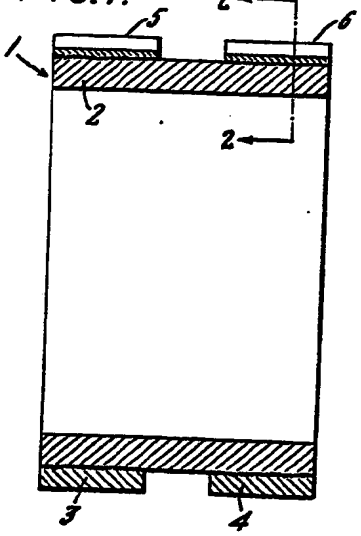

FIG. 2.

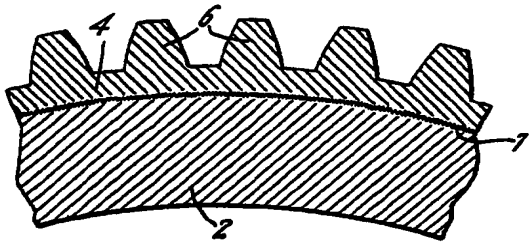

FIG. 3.

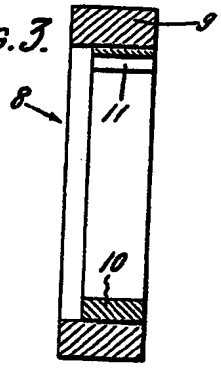

FIG. 4.